Research Translation in Spatiotemporal Exposure Assessment for Contaminated River Superfund Sites

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Pollution of rivers, such as those classified as Superfund sites, has a potentially serious impact on human health. Such water contamination may cause a reduction of the waters possible use as a resource for drinking water, swimming, or fishing. Hence, routine assessment of the water quality along these rivers plays a vital role in protecting public health. However, due to budget and scientific limitations, sampling data is usually insufficient to assess all river miles, and agency personnel lack the tools for advanced spatiotemporal exposure assessment. Therefore, there is a need for a reliable framework that can take into account the space/time variability of monitoring data for the assessment along unmonitored streams. In this work, we utilized the Bayesian Maximum Entropy (BME) mapping method of modern spatiotemporal geostatistics to provide a rigorous Bayesian framework to process all available surface water monitoring data distributed unevenly over space and time to produce a graphical user interface (GUI) that allows stakeholders to perform accurate assessments of water quality along complicated river networks. We illustrate the application of this framework using tetrachloroethylene data collected along the rivers of New Jersey, which have a complicated hydrographic network. We produced maps providing a stochastic description of the distribution of tetrachloroethylene at all times throughout the river network. Using a cross-validation procedure, we demonstrate that the spatiotemporal estimation framework developed in this work is substantially more accurate than a purely spatial estimation, leading to a significant decrease of non-assessed river miles and a more precise assessment of river segments that are highly likely to be in non-attainment of the standard. The GUI developed in this work using the highly portable Python programming language will provide a useful avenue for research translation of information to multiple stakeholders and users interested in spatiotemporal exposure assessment of contaminated rivers.

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